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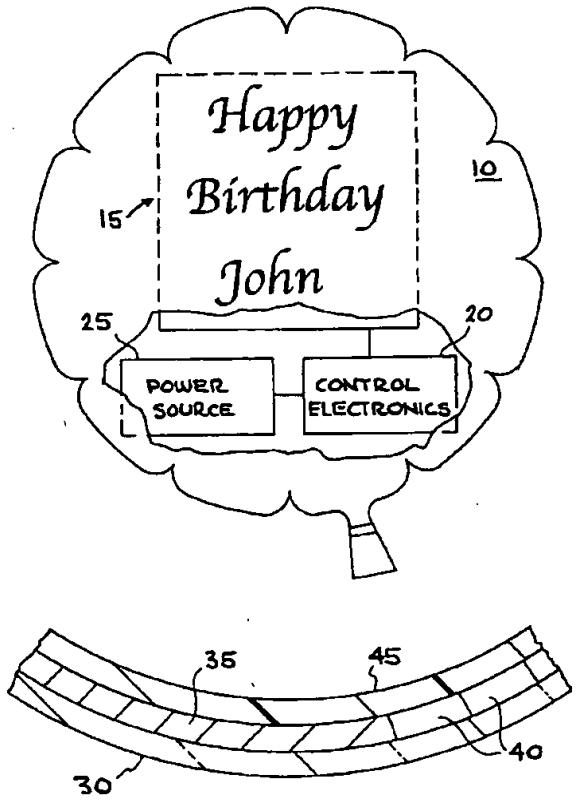
(54) Title: INFLATABLE ORGANIC LIGHT EMITTING DIODE TOYS



(57) Abstract: An inflatable device, such as children's toys, furniture etc. provided organic light emitting diodes deposited by known technology such as by inkjet. The organic light emitting diodes may be deposited on the inner surfaces or outer surfaces of toys, such as balloons, kites, ball, musical instruments, etc., or may be deposited between an inner and outer laminate, such as for inflatable furniture, basketballs, etc. The organic light emitting diodes are energized or activated by use of a solar cell/battery arrangement with a ball controlled by a switch or an external signal, for example; or by a central processing unit (CPU) which can send signals to one organic light emitting device or more. Also, the images may be changed or initiated by the CPU or by standard communicative devices, such as button activation, bounce/movement activation, voice activation, or by radio-frequency, infrared, or magnetic activation.

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INFLATABLE ORGANIC LIGHT EMITTING DIODE TOYS

Field of the Invention

The present invention relates to toys, particularly to light emitting toys, and more particularly to light emitting inflatable children's toys and furniture using organic light emitting diodes deposited on an inner or an outer surface or between an inner and outer laminate.

Description of Related Art

Light emitting diodes have gained recent interest and are arriving at the forefront of scientific applicability and consumer practicability because they are capable of delivering relatively bright colors to computer screens and other planar objects with relatively little energy and no need for back lighting. All of the current proposed organic light emitting diodes OLED's that have been made available to the public have been two-dimensional in nature and, therefore, planar. Organic light emitting diodes have even been placed on T-shirts, using inkjet processes. Typically most organic light emitting diodes are placed upon a hard surface. However, organic light emitting diodes may be applied to non-firm or foldable surfaces and are called flexible organic light emitting diodes (FOLEDs).

Numerous methods exist in the art to manipulate and create OLEDs, and such are exemplified by U. S. Patents No. 5,587,589, issued December 24, 1976 to E. So et al; No. 5,949,089 issued September 7, 1999 to J. Kim et al; No. 5,994,836 issued November 30, 1999 to W. Boer et al; No. 5,998,803 issued December 7, 1999 to S. Forrest et al; and No. 6,010,796 issued January 4, 2000 to V. Kijima.

The web site at www.universaldisplay.com, mentions the various forms of OLED's: TOLED's (Transparent Organic Light Emitting Devices for windshields, cockpits, helmets and eyeglasses), FOLED's (Flexible Organic Light Emitting Devices for flexible plastic or conformable surfaces), and SOLED's (Stacked Organic Light Emitting Devices for high resolution displays).

Children currently enjoy playing with toys such as air-filled or gas-filled balloons, air-filled toy inflatable furniture, fluid-filled, or gas-filled balls, air-filled or fluid-filled blimps and other objects. Some are meant to float or fly in a gaseous environment. These structures are three-dimensional in nature. Previously some of these structures have been lit using traditional or standard light emitting diode

technology, such as the placement of a light emitting diode deep within the area of basketballs and footballs, which are activated by pressing a button or inserting a pin into the ball. Nonetheless, the number of light emitting diode colors are limited and their large size makes it impossible to generate complicated images or patterns in practical devices. Basketballs commonly end up jostling or tearing the central solid light-emitting device loose, and failure is common with these devices.

Currently there exists a need for inner or outer or laminated surface coating inflatable children's toys, furniture, etc., such as balloons, balls, kites, blimps, chairs, tables, etc., that may be coated with or laminated with organic light emitting diodes (OLED's) deposited as by an inkjet mechanism or other methods known in the art.

The present invention provides a solution to the above referenced need by providing inflatable toys and furniture with OLED's. The OLED's are deposited on an inner surface, an outer surface, or between an inner and outer laminated surface. The OLED's power and control electronics can be activated by switch or button, by bounce/movement, or by voice, radio frequency, infrared, or magnetic means currently known in the art. The power source for the present invention can also be made of a flexible polymer for example, polymer lithium batteries, organic solar cells or polymer capacitor. Using all flexible components makes the toys compact, light weight, and robust.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide inflatable organic light emitting diode toys.

A further object of the invention is to provide inflatable children's toys with organic light emitting diodes deposited on inner, outer, or with laminated surface of the toys.

Another object of the invention is to provide inflatable children's toys with organic light emitting diodes and activation devices for the diodes.

Other objects and advantages of the present invention will become apparent from the following description and accompanying drawings. The present invention involves inflatable organic light emitting diode (OLED) TOYS. The toys are provided with at least one OLED deposited on either an inner surface or an

outer surface of the toy, or deposited intermediately on inner and outer laminated surfaces of the toys. Toys are defined as items children utilize, including inflatable furniture, such as chairs, etc., and particularly items such as inflatable balls, kites, balloons, blimps, etc. The OLED may be activated remotely or manually, and may be controlled, changed, etc. by signals from a microprocessor. The power source and electronics are also structurally flexible and light-weight. The OLED's may be deposited by known techniques such as inkjet processes.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated into and form a part of the disclosure, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

Figure 1 is a balloon that has been coated on its inner surface with organic light emitting diodes and then filled with a gas, such as helium.

Figure 2 shows a cross-sectional view of the flexible structure of one embodiment of the device.

Figure 3 illustrates a football with organic light emitting diodes located in the central or wall aspect.

Figure 4 shows a block diagram of the key components of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention involves inflatable organic light emitting diode (OLED) toys. By this invention the inner or outer, or laminated surfaces of inflatable children's toys, including but not limited to: balloons, balls, kites, musical instruments, or inflatable furniture, such as chairs, are coated or laminated with organic light emitting diodes by a process such as inkjet deposition or other methods known in the art. The invention is described hereinafter with examples illustrated in the drawings.

An organic light emitting diode (OLED), also called an organic electroluminescent (EL) device, is comprised of a layer of organic luminescent material conductively sandwiched between an anode, typically comprised of a transparent conductor such as indium-tin oxide and a cathode, typically a low work-function metal such as magnesium, calcium, aluminum, or the alloys

thereof with other metals. The EL device functions on the principle that under an electric field, positive charges (holes) and negative charges (electrons) are respectively injected from the anode and cathode into the luminescent layer and undergo recombination to form excitonic states which subsequently emit light. Prior art organic EL devices have been constructed from a laminate of an organic luminescent material and electrodes of opposite polarity, which devices include a single crystal material, such as single crystal anthracence, as the luminescent substance as described, for example, in U.S. Patent No. 3,530,325. However, these devices require excitation voltages on the order of 100 volts or greater. Subsequent modifications of the device structure through incorporation of additional layers, such as charge injecting and charge transport layers, have led to performance improvements. Illustrative examples of these type of EL devices have been disclosed in publications by Tang et al. in J. Appl. Phys. vol. 65, pp. 3610 to 3616 (1989) and Saito et al. in Mol. Cryst. Liq. Cryst. vol. 253, pp. 125 to 132 (1994).

An organic EL device can be fabricated with an organic dual layer structure comprising one layer adjacent to the anode supporting hole injection and transport, and another layer adjacent to the cathode supporting electron injection and transport. Another alternate device configuration is comprised of three separate layers, a hole transport layer, an emission layer, and an electron transport layer, which layers are laminated in sequence and are sandwiched as a whole between an anode and a cathode. Optionally, a fluorescent material can be added to the emission layer to induce recombination of charge carriers and emission of light within the fluorescent material, leading to improved luminescence efficiency.

A flexible, transparent plastic substrate for OLED applications is described by P.E. Burrows et al., in Proc. SPIE Vol. 4105, titled "Gas Permeation and Lifetime Tests On Polymer-Based Barrier Coatings." This article describes a process where a flexible, composite thin film barrier is deposited under vacuum onto commercially available polymers, restricting moisture and oxygen permeation rates to undetectable levels. The film is capped with a thin film of transparent conductive oxide yielding an engineered substrate (Barix™) for next

generation, rugged, lightweight of flexible OLED displays. Barix is a trademark of Vitex Systems, Sunnyvale, CA.

Figure 1 shows one embodiment of the present invention in which a flexible organic light emitting diode array **15** is bonded to a clear polyvinylchloride or mylar balloon **10**. The OLED's are in turn electrically connected to a microprocessor and control electronics **20** and a power source **25**. The OLED array **15**, power source **25**, and control electronics **20** can be bonded to the balloons internal or external surfaces or sandwiched between two polymer layers. In the preferred embodiment, polymer lithium batteries and polymer embedded electronics are used to produce a flexible, robust, and light-weight device. The balloon **10** when powered can display messages or images on the OLED array **15** with colors and clearly visible in bright lights or dark conditions.

Figure 2 shows a cross-sectional view of the flexible structure of one embodiment of the device. A clear protective polymer **30** protects the OLED array **35** and electronics **40** from the environment and abuse. The OLED array **35** and electronics **40** are sandwiched between the external polymer layer **30** and an internal polymer layer **45**. The internal polymer layer **45** may not be necessary for toys that do not require extra strength. The internal polymer layer can also be any desired color to provide a desired background for the lighting or message.

In addition, to simple balloons more sophisticated propeller driven toy blimps could also be equipped with flexible OLED arrays. Inflatable furniture could also be manufactured with internal OLED arrays that would provide simple internal lighting. The color of the lighting could be controlled externally by activating different OLED array elements.

Figure 3 illustrates how internal OLED's can be incorporated into the center or wall of a hollow football to produce a bright light emitting device. In contrast, to toys that currently use heavy light emitting diode the present invention doesn't require the inside volume to be filled with foam to protect and constrain the electronics and light source. The skin of the football **60** is made of a thick clear polymer that transmits light and bonds to the OLED array **65**. The flexible power source and control electronics **68** are bonded to the OLED array **65**. In another embodiment the empty volume within the football is filled with foam to eliminate

the need to inflate the football. The power source could be a rechargeable battery that is recharged through connector 70. An alternative power source would be a flexible polymer based capacitor that could be charged by an external RF source without the need for leads; alternatively, externally to power the OLED's. The OLED arrays in sporting equipment can be used to generate messages or simply to emit different color light. The light could also be made to flash, or change color in a controllable fashion. The internal microprocessor and control electronics can receive external commands to control the OLED array. An on-off switch located within the ball could be button activated, bounce/movement activated, voice activated, radio frequency activated, infrared activated or magnetically activated.

Figure 4 shows a block diagram of all the key components of the present invention. A polymer 80 supports an OLED array 85 that is controlled by electronic control unit 90 that receives its power from a power source 100. The electronic control unit 90 has two main electronic components. A microprocessor and memory 92 that control which OLED's are turned on or off at any instant of time and also contain the software to interpret commands received by the receiver 95. The receiver 95 can be an RF, optical, or infrared detector and necessary decoding electronics. For example, miniature single integrated circuit AM or FM receivers similar to those used in radio operated toys could be used with the present invention. Alternatively a direct connection could be made between an external controller and the internal microprocessor 92. For example, the external controller could be a handheld computing device like a palm pilot or a personal computer with a serial port, or USB port. The external controller can communicate what message or image is to be displayed or what color is to be displayed or combinations of the two. The power switch 110 can be pressure, RF, light, voice, motion or capacitance sensitive. The power source 100 is also a flexible device like a lithium polymer battery, a polymer based solar cell, or flexible capacitor. All of these power sources are well known in the art.

It has been shown that the present invention provides a technique by which flexible toys may incorporate OLED's to enable the toys to be light emitting, thereby making the toys more attractive to children. This invention is particularly

suited to inflatable or flexible toys but can be valuable for placing LED arrays on any curved surface.

While particular embodiments have been described and illustrated to exemplify and teach the principles of the invention, such are not intended to be limiting. Modifications and changes may become apparent to those skilled in the art, and it is intended that the invention be limited only by the scope of the appended claims.

We claim:

1. A toy having at least one organic light emitting diode deposited on a surface of the toy, wherein said surface is selected from the group consisting of an inner surface, an outer surface, and intermediate a dual laminated surface.

2. The toy of Claim 1, in combination with a power source selected from the group consisting of a solar cell, battery and capacitor for the organic light emitting diode; and means to turn power on and off.

3. The toy of Claim 1, which is selected from the group consisting of a flexible toy, a fluid inflatable toy and a gas inflatable toy.

4. The toy of Claim 3, which is selected from the group consisting of children's furniture, balls, kites, gas filled objects, fluid filled objects, flying objects and musical instruments.

5. The toy of Claim 3, having a plurality of organic light emitting diodes in combination with means for selectively activating any one or more of said organic light emitting diodes.

6. The toy of Claim 5, wherein said means includes a memory for storing an image or message to be illuminated by at least one organic light emitting diode.

7. The toy of Claim 6, further comprising a means to communicate with an externally located control unit.

8. The toy of Claim 7, wherein said means to communicate with said externally located control unit includes receiving and decoding signals selected from the group consisting of RF signals, optical signals, infrared signals and acoustic signals.

9. A process which includes forming organic light emitting diodes on a surface of an inflatable toy wherein the surface is selected from the group of an internal surface, an external surface, and a laminated surface.

10. The process of Claim 9, which additionally includes incorporating a memory that can store an image or message to be generated with the formed organic light emitting diodes.

11. The process of Claim 9, which additionally includes placing a digital input into the thus formed organic light emitting diode using infrared, electromagnetic, radio frequency, magnetic, or plug-in messaging.

12. The combination of organic light emitting diodes and an inflatable toy or furniture.

13. The combination of Claim 12, wherein said inflatable toy or furniture includes gas-filled objects, fluid-filled objects, chairs, kites, balls, flying objects, and musical instruments.

14. The toy of claim 1, wherein said at least one organic light emitting diode is controlled by an on-off switch located within the toy and activated by one of a group consisting of button activated, bounce/movement activated, voice activated, radio frequency activated, infrared activated and magnetically activated.

15. The toy of claim 1, wherein said at least one organic light emitting diode is connected to a power source selected from the group consisting of a rechargeable battery, a flexible polymer based capacitor and a polymer lithium battery.

16. The toy of claim 15, wherein the power source comprises a flexible polymer based capacitor charged by an external RF source.

17. The toy of claim 1, including a plurality of organic light emitting diodes deposited on a surface of the toy, an electronic control operatively connected to said diodes, and a power source operatively connected to said electronic control.

18. The toy of claim 17, wherein said electronic control includes a microprocessor and a receiver.

19. The toy of claim 18, wherein said receiver is constructed to receive a signal selected from the group consisting of an RF signal, an optical signal and an infrared signal.

20. The toy of claim 17, wherein said power source comprises a flexible device selected from the group consisting of a lithium polymer battery, a polymer based solar cell and a polymer based capacitor, wherein said power source includes a switch selected from the group of activated switches consisting of pressure, RF, light, voice, motion and capacitance sensitive.

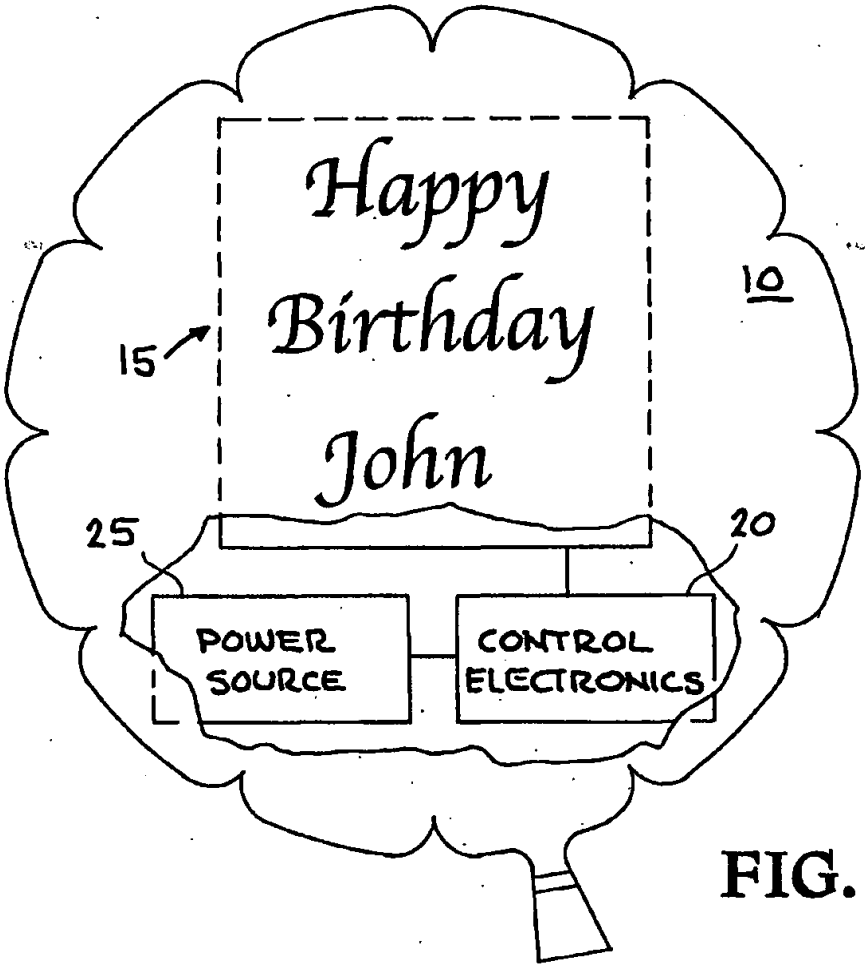

FIG. 1

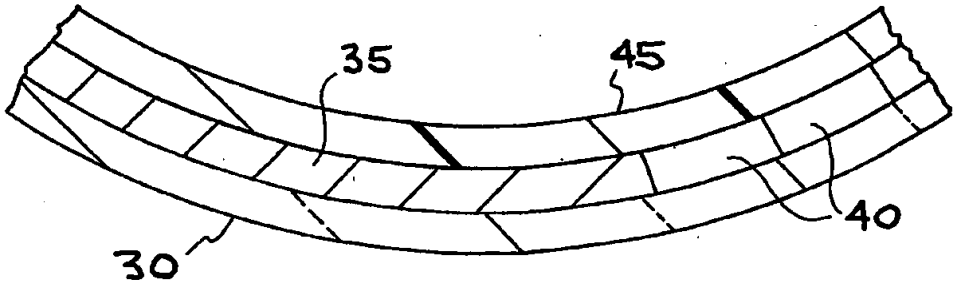

FIG. 2

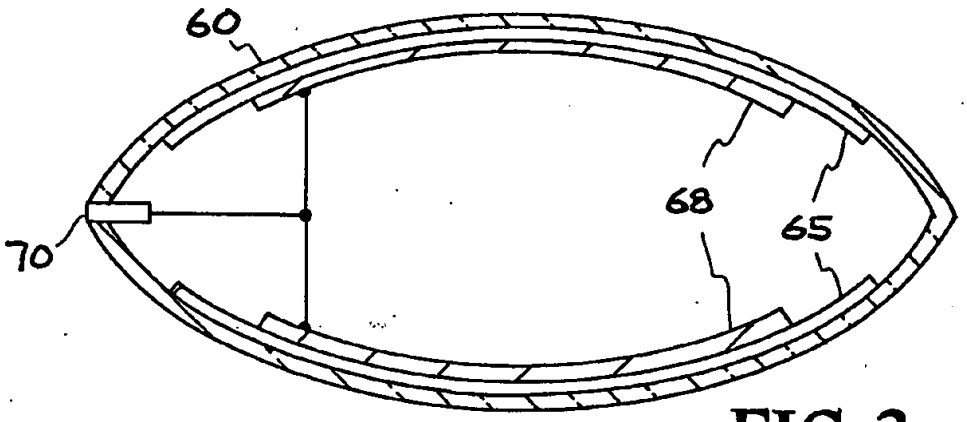

FIG. 3

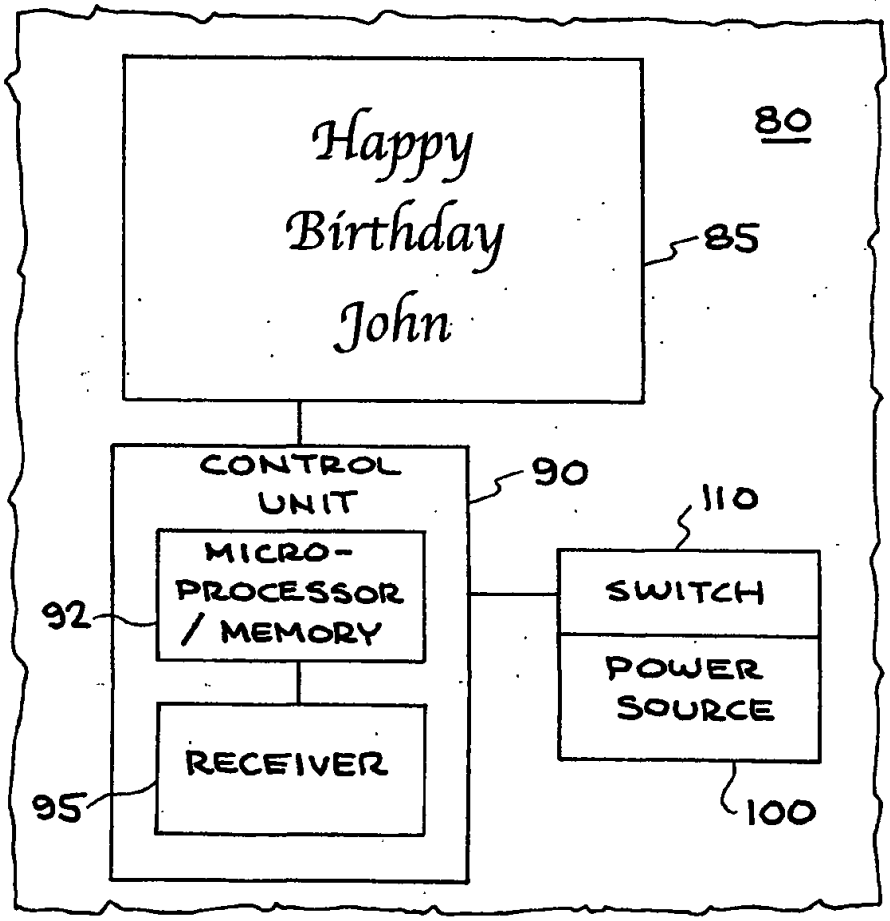

FIG. 4